COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

The National Science Foundation's (NSF's) Directorate for Computer and Information Science and Engineering (CISE) has three goals:

- to enable the United States to hold a position of world leadership in computing, communications, and information science and engineering;
- to promote understanding of the principles and uses of advanced computing, communications, and information systems in service to society; and
- to contribute to universal, transparent, and affordable participation in an information-based society.

To achieve these goals, the CISE Directorate supports investigator-initiated research in all areas of computer and information science and engineering; helps develop and maintain cutting-edge national computing and information infrastructure for research and education in general; and contributes to the education and training of the next generation of computer scientists and engineers.

CISE activities are core to NSF's efforts in information technology, including the Information Technology Research Program. The directorate's activities in fiscal year 2002 (FY 02) encompass broad, thematic, large-scale, and long-term basic computer science research, emphasizing software, human-computer interaction, information management, scalable information infrastructure, high-end computing, and the economic and social implications of information technology. Support will be provided for individual investigator and group research projects and for a limited number of information technology research centers. Complete descriptions of the program and details on proposal submission will be available on the CISE Directorate home page in FY 02.

The CISE Directorate supports programs and activities through the following:

- **Crosscutting Programs and Activities**
- **Division of Computer-Communications Research (C-CR)**
- **Division of Information and Intelligent Systems (IIS)**
- **Division of Advanced Computational Infrastructure and Research (ACIR)**
- **Division of Advanced Networking Infrastructure and Research (ANIR)**
- **Division of Experimental and Integrative Activities (EIA)**

CISE is inherently multidisciplinary, and the directorate strongly encourages collaboration with all NSF-supported disciplines. Several CISE programs—such as Research Infrastructure,

Instrumentation, and Educational Innovations—encompass all fields of computer and information science and engineering and are managed on a cross-divisional basis.

In addition to supporting research, the CISE Directorate provides the general scientific community with access to advanced computing and networking capabilities. Programs such as Partnerships for Advanced Computational Infrastructure give qualified users access to extremely powerful computing resources, train users, and develop the software required for effective use. Networking activities offer and build a national infrastructure for computer and human interaction as well as communication for research and education. In addition, the directorate supports distributed research resources and systems for research and education, and educational development through various activities such as educational infrastructure and educational supplements.

For More Information

Visit the CISE Directorate home page, http://www.cise.nsf.gov/.

CROSSCUTTING PROGRAMS AND ACTIVITIES

In addition to the programs mentioned in this section, the CISE Directorate takes an active role in the following crosscutting programs and activities:

- **Information Technology Research**
- **Biocomplexity in the Environment**
- **Learning for the 21st Century**
- **Nanoscale Science and Engineering**

ⓘ For More Information

Visit the NSF Crosscutting Programs home page, http://www.nsf.gov/home/crssprgm.

DIVISION OF COMPUTER-COMMUNICATIONS RESEARCH

The Division of Computer-Communications Research (C-CR) supports research in a broad array of areas as well as interdisciplinary research in the context of computer science and engineering. Special areas of emphasis in C-CR include system security and assurance, nano-scale computation, hybrid and embedded systems, mobile computing, and mathematical computation.

The C-CR Division supports the following programs and activities:

1. **Communication Research**
2. **Computer Systems Architecture**
3. **Design Automation**
4. **Numeric, Symbolic, and Geometric Computation**
5. **Operating Systems and Compilers**
6. **Signal Processing Systems**
7. **Software Engineering and Languages**
8. **Theory of Computing**
9. **Hybrid and Embedded Systems**

ⓘ For More Information

Write to the Division of Computer-Communications Research, National Science Foundation, 4201 Wilson Boulevard, Room 1145, Arlington, VA 22230; or contact the division by telephone, 703-292-8910; or visit the C-CR home page, http://www.cise.nsf.gov/ccr/index.html.

1. Communication Research (COM)— Supports research in all aspects of communication science and technology in order to facilitate the efficient representation and transmission of information so as to approach theoretical limits more closely than ever before. This includes efficient representation of information sources; means for densely packed storage and efficient retrieval of information; modern modulation and coding techniques exploiting the temporal and spatial redundancy of channels; resource allocation algorithms working across layers, from physical to presentation; security methods attuned to the requirements of modern e-commerce; and so on. Historically, research in communications was either focused on the so-called physical layer or on the networking layers, with little interplay across this artificial boundary. More recently, societal demands for instant, mobile access to information resources are motivating a more synergistic approach to research in communications. These societal desires are

fed by technological developments like the Internet and high-density storage. They have inspired new research developments while resurrecting older technologies and algorithms, with new twists in order to provide the necessary, high-capacity communication means. It is the goal of this program to sponsor cutting-edge research that will provide the scientific basis for meeting the information requirements of our society in a 5- to 20-year timeframe from the present.

2. Computer Systems Architecture— Supports fundamental research on new computing systems. Focus is on new architecture ideas and concepts that will form the basis for solving computing problems likely to arise in the future. Broadly, this covers design, implementation, and evaluation of novel computing structures and technologies. Theoretical and small-scale experimental studies are supported, as are assessments of fault tolerance and performance. Also supported is research on system software, when intimately connected to the architecture or hardware.

Currently, special attention is given to research in the following areas: metrics (benchmarks, new applications, nonperformance metrics); parallelism (including small-scale and mpps); systems of systems (latency reduction, bandwidth increase, processor-in-memory, input/output, interconnects, new device support); small scale MP's, roughly 2-100 nodes (synchronization, communication, protection, memory system structure, reliability, performance metrics, compiler architecture interaction); memory (bandwidth, latency questions, hierarchy management); interconnect (fault tolerance, dynamics of faults and recovery, reliability, quality of service); processor-in-memory (PIM) (single and multiple PIM's, new architectures); input/output (availability, scalable I/O, performance, data stream management, low overhead protection, latency tolerance); single-thread computing (prediction and speculation, architectural support, control implification); multiple-thread computing (multiscalar, dynamic sharing, communication, synchronization, multiple independent processors); protection (nontrusted applications coming in off the Net, security, privacy); and molecular systems (architecture specification, design concepts and tools, simulation of molecular systems).

3. Design Automation—Supports basic research in electronic design automation (EDA) and those areas in which Very Large Scale Integration (VLSI) design technology is applicable, such as systems-on-a-chip, embedded systems, and multitechnology (optical, micro-electro-mechanical, etc.) design methods. Research covers all phases of the complete design cycle for integrated circuits and systems, from conception through manufacturing test. Topical areas of VLSI design technology include theoretical foundations, models, algorithms, tools, analysis, synthesis, simulation, validation, and verification; system design methodologies (systems-on-a-chip, multichip, and multitechnology systems); manufacturing (fault models and algorithms for diagnosis and test in digital, analog, and mixed signal designs); and design and system prototyping methods, tools, and environments, especially the information infrastructure aspects.

4. Numeric, Symbolic, and Geometric Computation (NSGC)—Supports fundamental research in areas where advanced algorithmic and computational techniques are coupled with mathematical methods of analysis. Specific program areas include computationally oriented numerical analysis; mathematical optimization; symbolic and algebraic computation; computational geometry; computational logic and automated deduction; and computer graphics. The program also supports advanced

computational techniques for simulation of physical processes; design and construction of high-quality mathematical computing software for scientific research; and experimental implementation when it is an integral part of the research. The program also encourages the integration of numeric, symbolic, geometric, and graphic techniques into problem-solving environments to support computational science and engineering. Innovative applications of advanced computational and graphic techniques in science and engineering applications, manufacturing and design, proof support systems, and prototypic and design verification are also welcome.

5. Operating Systems and Compilers (OSC)—Supports research on the development, design, evaluation, and implementation of computing systems ranging from operating systems, compilers, and runtime systems to middleware for the integration of heterogeneous systems and information sources. In operating systems and distributed systems, topics of interest include the development of mechanisms and application programming interfaces for uniform access and management of resources in local area networks and wide area networks; middleware infrastructure for building scalable services; resource management for new applications and quality-of-service requirements; security; and electronic commerce. In compilers and runtime systems, the topics of interest include dynamic compilation; techniques that include various models of storage consistency and storage-hierarchy performance; and compiler support for programming on the web.

6. Signal Processing Systems (SPS)—Supports fundamental research in the areas of digital signal processing, analog signal processing, and supporting hardware and software systems. Included are one-dimensional digital signal processing (1-D DSP), including (adaptive) filtering and equalization and time-frequency representations; statistical signal and array processing; image and multidimensional digital signal processing, including image analysis, filtering, restoration and enhancement, image and video coding, and vector quantization; and analog signal processing, including analog-to-digital conversion and analog circuits and filters.

Currently, special attention is given to antenna array processing with application to wireless communications systems, especially cellular telephony, personal communications systems, and wireless local area networks; signal compression for reduced data rate with applications to wireless communications systems; scalable/progressive/multiresolution approaches in signal decomposition, compression, and other signal processing techniques to support content analysis; data quality validation; and manufacturing applications (e.g., nondestructive test and evaluation), computed tomography, and synthetic aperture radar (SAR).

7. Software Engineering and Languages (SEL)—Supports fundamental research underlying the development and evolution of quality software-based systems. Projects may study or develop methods, processes, tools, or environments, taking a conceptual, experimental, or developmental approach, or may represent innovative work in the theory and design of programming languages, language semantics, and programming environments.

Specific research topics include domain-specific languages for specification and design; constructive approaches to software design and evolution; issues of software modularity and composition; enhancement of confidence and quality; automating stages of software development; distributed and network environment issues, including distributed development and software security; and formal foundations for all

aspects of software engineering and programming languages. Experimental approaches to concept validation are strongly encouraged as a necessary adjunct to conceptually motivated research. Projects contributing to an experimental research infrastructure by providing access to testbeds, software development data, or repositories of software project artifacts will be considered.

8. Theory of Computing (TOC)— Supports fundamental research in the following areas:

- Core Theory: Covers computational complexity, cryptography, interactive computation, computational learning theory, parallel and distributed computation, computation on random data, online computation, and reasoning about knowledge.

- Fundamental Algorithms: Includes developing combinatorial, approximation, parallel, online, numerical, geometric, and graph algorithms that transcend application domains.

- Application-Specific Theory: Supports developing models and techniques for solving problems that arise in areas of science and engineering such as molecular biology, communications networks, and computational linguistics.

Also of interest are theoretical developments that have potential impact on experimental or applied areas of computer science research. Investigators are encouraged to pursue strategies that mix theory with experimentation.

9. Hybrid and Embedded Systems (HES)—Supports research in scientific principles and technology to revolutionize the design and development of embedded systems for a broad range of applications. Software has enabled increasingly ambitious, often safety-critical systems such as transportation, manufacturing, medical devices and systems, environmental control, and energy management. These include distributed and coordinated embedded systems that demand high levels of autonomy, adaptivity, and component integration, such as multimodal sensing and control. Embedded systems combine interacting elements, including timing, spatial, physical properties, and continuous dynamics of the system to be monitored or controlled; the timing and synchrony properties and resource demands of software that controls the system; and the characteristics and services of the computational platform, both systems software and hardware. A foundation is currently lacking for systematic integration of these elements, particularly for increasingly complex systems.

The goal of the HES Program is to create and unify the foundations for managing interacting physical and computational systems and to supply the technologies needed for building reliable software- and network-enabled embedded systems. The program draws on control theory, modeling, software generation, software systems, and formal verification. Relevant research includes areas such as hybrid (discrete and continuous) modeling and control of physical systems, domain-specific design, programming, and software synthesis approaches for embedded systems; verification technology for checking and certifying correct operation of embedded systems; real-time open systems, middleware, and virtual machine strategies for embedded systems; dynamic scheduling accommodating hard and soft real-time; and program composition approaches for synthesizing software while preserving essential properties.

DIVISION OF INFORMATION AND INTELLIGENT SYSTEMS

The Division of Information and Intelligent Systems (IIS) supports research that will improve the ability to generate, organize, locate, communicate, and store knowledge using new technologies. IIS recognizes that high-quality content and its accessibility and usability are important benefits provided by new technologies and are complementary to bandwidth and disk space. IIS fundamental research foci include universal access; human language technology; knowledge modeling; scientific collaboratories; robotics; computer vision; data mining; database access technology; human-computer interaction; and embedded intelligent systems. IIS also supports interdisciplinary and interagency activities such as the Digital Libraries and STIMULATE (Speech, Text, Image, and Multimedia Advanced Technology Effort) Initiatives.

The IIS Division supports the following programs and activities:

1. **Digital Society and Technologies**
2. **Human-Computer Interaction**
3. **Information and Data Management**
4. **Knowledge and Cognitive Systems**
5. **Robotics and Human Augmentation**
6. **Special Projects**
7. **Universal Access**

ⓘ For More Information

Write to the Division of Information and Intelligent Systems, National Science Foundation, 4201 Wilson Boulevard, Room 1115, Arlington, VA 22230; or contact the division by telephone, 703-292-8930; or visit the IIS home page, http://www.cise.nsf.gov/iis/index.html.

1. Digital Society and Technologies— Supports research fundamental to the development of new knowledge about the complex processes of adaptation and interchange between society and new information technologies. New theories, models, and technologies are encouraged, as well as empirical maps of the landscape of social and economic change. Research topics include universal participation in a digital society; large-scale social technologies for science, education, and work collaboration and learning; ethical principles in technical design; information privacy and intellectual property in a digital age; and technologies for independence throughout life.

2. Human-Computer Interaction— Supports research fundamental to the design of systems that mediate between computers and humans. Topics include universal access; visualization; animation and simulation; interactive computing; human language technology, including speech recognition and natural language understanding; posture- and sound-based interfaces; virtual reality; and multimedia environments.

3. Information and Data Management— Supports research fundamental to the design, implementation, development, management, and use of databases; information retrieval; and knowledge-based systems. Topics include data, metadata, information, and knowledge process modeling; information access and interaction; knowledge discovery, data mining, and visualization; and system architecture and implementation. Research areas span web-based systems, multimedia systems, scientific databases, geographic information systems, digital libraries, and other intelligent information systems; efficient data gathering and storage/ archival; information organization,

information flow management, and security/privacy issues; evolutionary systems, change maintenance, and information life-cycle management; heterogeneous systems; and highly scalable, data-intensive, and distributed/mobile information systems.

4. Knowledge and Cognitive Systems— Supports research fundamental to the development of machines that behave intelligently. This can be in conjunction with humans (computer-aided machine intelligence) or alone (autonomous intelligent agents). Some of the research involves knowledge representation in machines and studies of cognitive processes, which may be modeled on what we know of human or animal cognition, or which may use approaches different from those in humans and animals. Cognitive activities of interest include multiple types of machine learning, planning, reasoning, decisionmaking, sensory cognition, and linguistic cognition, or combinations of these in intelligent agents. Fundamental research in these areas may have as a goal, for example, the application of integrated design and manufacturing; network management; medical diagnosis; data mining; or intelligent tutoring.

5. Robotics and Human Augmentation— Supports research fundamental to the design of machines and systems that implement some characteristics of intelligence and are capable of performing tasks that require generation of mechanical motion. Research topics include theoretical, algorithmic, experimental, and hardware issues on macro-, micro-, and nanoscale, with an emphasis on intelligent sensing and unstructured environments; personal robotics with an emphasis on its human-centered end-use; robotic applications such as systems for surgery, undersea, space, and agriculture; complex sensing, perception, and action; understanding and processing of visual data; representation, reasoning, and planning for complex physical tasks involving temporal and spatial relationships; communication and task sharing between human and machine and among machines; and cooperation among geographically separated robotics resources.

6. Special Projects—Supports research, workshops, and other interdisciplinary activities focusing on computing, communications, and the development and use of digital content in a variety of scholarly, social, and work contexts. Special Projects is the managing program for the Digital Libraries Initiative and is global in scope, promoting international collaboration across a wide range of topics related to the expansion of the capabilities and use of the Internet.

7. Universal Access—Aims primarily to support research fundamental to empowering people with disabilities so that they are able to participate as first-class citizens in the emerging information society. The program also seeks to advance computer technology so that all people can possess the skills needed to fully harness the power of computing. Focus is on topics such as the development of new models, architectures, and languages that emphasize interface speed and usability by all; the definition of semantic structures for multimedia information to support cross-modal input/output; the development of specific solutions to address the special needs of large disabled communities; and experimental studies to evaluate the success of attempts to provide access in all its varied forms. The word "access" implies the ability to find, manipulate, and use information in an efficient and comprehensive manner.

DIVISION OF ADVANCED COMPUTATIONAL INFRASTRUCTURE AND RESEARCH

The Division of Advanced Computational Infrastructure and Research (ACIR) provides access to and support of high-end computing infrastructure and research for the national scientific community through its programs.

The ACIR Division supports the following programs and activities:

1. **Advanced Computational Research**
2. **Partnerships for Advanced Computational Infrastructure**
3. **Terascale Computing System**

ⓘ For More Information

Write to the Division of Advanced Computational Infrastructure and Research, National Science Foundation, 4201 Wilson Boulevard, Room 1122, Arlington, VA 22230; or contact the division by telephone, 703-292-8970; or visit the ACIR home page, http://www.cise.nsf.gov/acir/index.html.

1. Advanced Computational Research— Supports a range of enabling technologies needed to advance the state of the art in high performance computing, and brings advanced computing and simulation capabilities to bear on fundamental problems throughout science and engineering. Technologies of particular interest include (a) data handling and visualization; (b) scalable systems; and (3) high-performance algorithms and applications. For details on each of the three focus areas and for specific program information, see program announcement NSF 98-168.

2. Partnerships for Advanced Computational Infrastructure (PACI)— Provides the resources and technical expertise to meet the expanding need for high-end computation and information technologies required by the U.S. academic community. The PACI Program supports two partnerships, each consisting of a leading-edge site and a significant number of partners. The two leading-edge sites maintain a variety of high-end computer systems. Together with partners who support smaller versions of these and other computers and experimental systems, they constitute a distributed metacomputing environment that is connected via high-speed networks. PACI sites also participate in the development, application, and testing of the necessary software, tools, and algorithms that contribute to the expansion of this "national grid" of interconnected, high-performance computing systems.

The activities of the partnerships focus on the following: accessibility to a diverse set of advanced and mid-range computer engines, data storage systems, and experimental machine architectures; enabling technologies—through the development of software tools for parallel computation and software for use on the partnerships' widely distributed and architecturally diverse machines and data sources, thus enabling effective use of the partnerships' very large distributed systems; application technologies—engage groups in high-end applications to develop and optimize their discipline-specific codes and software infrastructures, making them available to the program as a whole and to researchers in other areas; education outreach and training—build a growing awareness and understanding of how to use high performance computing and communica-tions resources and broaden the base of participation to help ensure the Nation's

continued world leadership in computational science and engineering.

3. Terascale Computing System— Provides a multiteraflop computing system in support of science and engineering research in the United States. NSF bears special responsibility for this national program, which is available for use by the national computational community. The system will be fully available in winter 2001 and is balanced in terms of processor speed, memory, communications, and storage. It is a part of the portfolio of resources provided by the PACI Program, and supplements the capabilities that are available through the PACI partnerships. For further information, see program announcement NSF 00-29.

DIVISION OF ADVANCED NETWORKING INFRASTRUCTURE AND RESEARCH

The Division of Advanced Networking Infrastructure and Research (ANIR) is concerned with Networking Research (ANR) and Networking Infrastructure (ANI).

The ANIR Division supports the following programs and activities:

1. **Advanced Networking Infrastructure**
2. **Networking Research**
3. **Special Projects**
   - **–Network Centric Middleware Services**
   - **–High Performance Network Connections for Science and Engineering Research**
   - **–Strategic Technologies for the Internet**

For More Information

Write to the Division of Advanced Networking Infrastructure and Research, National Science Foundation, 4201 Wilson Boulevard, Room 1175, Arlington, VA 22230; or contact the division by telephone, 703-292-8950; or visit the ANIR home page, http://www.cise.nsf.gov/anir/index.html.

1. Advanced Networking Infrastructure— Seeks to stimulate, contribute to, and make available for the research and education communities the very latest in high-performance networking capability in both the national and international arenas. The program seeks to enable the use of novel and advanced research applications across all disciplines of science and engineering; coordinate interactions with networking and other disciplines of science; and promote the analysis, improvement, and evolution of the Internet. The focus has shifted from backbone networks to middleware and network services, networked applications, and networking for new participants. Subprograms within this activity include the following:

- Network Centric Middleware Services: Enables those entities who compose the advanced network community, including research universities, government agencies, and industrial units, to collaborate in assembling known and needed pieces of Network Centric Middleware Services. Middleware refers to the software that is common to multiple applications and builds on the network transport services to enable ready development of new applications and network services. By producing a working software distribution, this program will assemble the known pieces and highlight places where new knowledge is needed. Research is also supported on issues relating to this area, to accomplish the above goals. For

specific program information, see program announcement NSF 01-63.

- High Performance Network Connections for Science and Engineering Research: Seeks to provide high performance network connection support for institutions of higher education that are not currently connected to an advanced network, and encourages additional U.S. institutions to established such a high performance Internet connection when such a connection is required to advance an area of scientific research. For example, researchers at an institution that is not yet connected may wish to collaborate on a research project that requires high performance networking with investigators at other institutions. For specific program information, see program announcement NSF 01-73.

- Strategic Technologies for the Internet: Improves the operational or functional capabilities of the Internet and enables related collateral efforts for the benefit of the research and education communities. Areas of support include but are not limited to complex network monitoring, problem detection, and resolution mechanisms; development of automated and advanced network tools, networked applications tools, or network-based middleware; creation of usable and widely deployable networking applications that promote collaborative research and information sharing; and innovative access network technologies. For specific program information, see program announcement NSF 01-90.

2. Networking Research—Focuses on the fundamental science and technology needed to facilitate the efficient high-speed transfer of information through networks and distributed systems. Projects funded range from network design and performance evaluation to middleware and software frameworks in support of applications running on top of networks and distributed systems. Projects may also address how networked and distributed systems interact with underlying communications technology and with other related disciplines. Research areas include high-speed, optical, wireless, and mobile networks; traffic control; resource management; quality of service; protocols; multicast; network security, design, and management; performance evaluation; network architectures; network systems; object-oriented frameworks for networks; agent-based networks; multimedia applications; and multiple-access platforms. For specific program information, see program announcement NSF 98-164.

3. Special Projects—Differs from the Networking Research Program in that it supports larger and more multidisciplinary projects, specialized hardware and software, or networks for networking systems research. Projects supported by this program focus on networking issues and may include work from other disciplines of computer science and engineering, such as distributed systems, communications, operating systems, databases, software, signal processing, control theory, and devices. Theoretical research activities that address networking issues require small teams of researchers. Experimental research that demonstrates proof of concept for novel networking ideas may range in scope from laboratory experimentation to national collaborations. For specific program information, see program announcement NSF 98-120.

DIVISION OF EXPERIMENTAL AND INTEGRATIVE ACTIVITIES

The Division of Experimental and Integrative Activities (EIA) supports experimental research, spans several areas, and often involves infrastructure needs. In particular, EIA promotes the development of experimental computer and communications research; furthers the evolution of multidisciplinary research involving the Computer and Information Science and Engineering (CISE) Directorate and other disciplines; contributes to the creation of a diverse personnel pool; carries out exploratory and prototype projects that cross organizational boundaries; operates special international activities; and supports special studies and analyses of issues that affect disciplinary areas supported by the CISE Directorate. In addition, EIA plays a major integrative role in CISE by linking research and education through support for both CISE-specific and NSF-wide activities.

The EIA Division supports the following programs and activities:

1. **CISE Research Resources**
2. **CISE Educational Innovation**
3. **CISE Minority Institutions Infrastructure**
4. **CISE Postdoctoral Research Associates**
5. **CISE Research Infrastructure**
6. **Biological Information Technology Systems**
7. **Combined Research-Curriculum Development**
8. **Digital Government**
9. **Quantum and Biologically Inspired Computing**
10. **Integrative Graduate Education and Research Training**
11. **Major Research Instrumentation**
12. **Next Generation Software**
13. **NSF-CONACyT Collaborative Research Opportunities**
14. **NSF-CNPq Collaborative Research Opportunities**
15. **Research Experiences for Undergraduates**
16. **Special Projects**

ⓘ For More Information

Write to the Division of Experimental and Integrative Activities, National Science Foundation, 4201 Wilson Boulevard, Room 1160, Arlington, VA 22230; or contact the division by telephone, 703-292-8980; or visit the EIA home page, http://www.cise.nsf.gov/eia/index.html.

1. CISE Research Resources (CISE-RR)—Is designed to increase the capability and capacity to carry out basic research in information technology at U.S. institutions. The program supports the acquisition and/or development of advanced resources for research and integrated research/education activities. Resources may include research equipment, instrumentation, software, data repositories, or services. Resources supported under this program are those generally not supported by other programs because of cost, complexity, level of shared use, or other reasons. CISE-RR consists of the following three elements:

- CISE Instrumentation: Supports grants for the acquisition and purchase of research resources in areas of science or engineering supported in the CISE Directorate. These research resources should be required for at least two research projects and no more than four research projects.

- Collaborative Research Resources: Supports grants to support the establishment, enhancement, and operation of major resources for multi-

investigator, synergistic or integrated research/education. Awards may be for activities solely within a single academic department, activities drawing from several departments in a single institution, or activities spanning several different institutions.

- Distributed Research Resources: Supports grants for the establishment and maintenance of unique, geographically distributed resources that, once established, can be accessed remotely by CISE researchers around the country.

2. CISE Educational Innovation— Supports innovative educational activities at the undergraduate level in computer and information science and engineering that transfer research results into the undergraduate curriculum. Projects supported are expected to show promise as a national model of excellence by acting as a prototype for use by a broader segment of the CISE community. Proposals may address a variety of educational activities, including the development of courses, instructional technologies, software, and other educational materials. A related program, Combined Research and Curriculum Development, in cooperation with the Engineering Directorate, supports multidisciplinary projects in upper-level undergraduate and introductory graduate-level curricula. For specific program information, see program announcement NSF 00-33.

3. CISE Minority Institutions Infrastructure—Provides awards to aid efforts that might significantly expand the numbers of minority students attracted to and retained in computer and information science and engineering disciplines. Eligible institutions must be minority institutions (defined by significant percentages of minority students). The program considers a variety of activities, including research programs involving minority students, curriculum development projects, mentoring, and outreach. Both 1-year planning grants and continuing grants of up to 5 years in duration are awarded. Significant matching for the latter (usually 25 percent) is expected. For specific program information, see program announcement NSF 96-15.

4. CISE Postdoctoral Research Associates—Aims to increase the expertise in experimental computer science and engineering by providing opportunities to work in established laboratories performing experimental research in computer science and engineering. Through these awards, recent Ph.D.'s are able to broaden their knowledge and experience and prepare for significant research careers on the frontiers of experimental computer science. For specific program information, see program announcement 97-169.

5. CISE Research Infrastructure— Provides support for the establishment, enhancement, and operation of major experimental facilities for all CISE research areas. Projects supported usually involve several individual projects with synergy among their research activities. CISE area Ph.D. degree-granting departments or partnerships with at least one such partner are eligible. Outreach to underrepresented groups is another program goal. For specific program information, see program announcement NSF 00-5.

6. Biological Information Technology Systems (BITS)—Supports high-risk/high-return research at the interface of biology and information technology. Biological systems have enormous capabilities as powerful and agile control systems for robotic and regulatory systems and for pattern recognition, adaptability, information storage, retrieval and processing, sensor fusion, and other information-handling

tasks. Biology often performs orders of magnitude better than systems based on today's silicon device technologies. Determining what needs to be and what can be learned about information processing in biological systems should lead to important new information systems (algorithms, software, and systems) and technologies (computer platforms, sensors, robotic devices, etc.). The initial phase of this program will focus on developing computational models and theories for the information-processing mechanisms encountered in biological systems that will lead to new information technology systems and hardware platforms. While these new information technology systems will not necessarily or exclusively be implemented in biological matter, the program will emphasize hybrid (bio-silical) systems, particularly as a means for experimenting with and validating new theories of biological information technologies and systems.

7. Combined Research-Curriculum Development (CRCD)—Emphasizes the need to incorporate exciting research advances in important technological areas into the upper-level undergraduate and graduate engineering curricula. A major objective of the program, which is jointly supported by the CISE Directorate and the Engineering Directorate, is to stimulate faculty researchers to place renewed value on quality education and curriculum innovation in the context that education and research are of equal value and complementary parts of an integrated whole.

Each project supported by the CRCD Program focuses on a particular topic that is of importance to industry and to the Nation in areas supported by both Directorates. In addition, each CRCD project contains five major components: research, curriculum development, a team of participants (faculty and students), project evaluation plans, and cost sharing of at least 25 percent. For specific program information, see program announcement NSF 00-66.

8. Digital Government—Aims to build a research domain of problems that intersect the traditional CISE research communities with the mid- to long-term research, development, and experimental deployment needs of the Federal information service communities. It accomplishes this by supporting projects that innovatively, effectively, and broadly address potential improvement of agency, interagency, and intergovernmental operations and government-citizen interaction. The Federal Government is a major user of information technologies, a collector and maintainer of very large data sets, and a provider of critical, often unique information services to individuals, states, businesses, and other customers. Still, most Federal agencies are struggling with the creation of a strategic vision and an operational philosophy for information technologies. For specific program information, see program announcement NSF 99-103.

9. Quantum and Biologically Inspired Computing (QUBIC)—Supports interdisciplinary research to improve the fundamental capabilities of computer science by incorporating insights from either biological systems or quantum foundations or both. To achieve this improvement, there needs to be fundamental research into the unification of information science across computer science, physics, biology, and engineering. Expanding research efforts in interdisciplinary areas at the interface of information science and technology with the fields of biology, chemistry, engineering, physics, and computer science will lead to better understanding in all areas of science. This will increase the ability to develop future information technologies that are very critical to the economy and society at the national and international level. Priority is given to group proposals that represent multiple disciplines, although single-

investigator proposals that are cross-disciplinary are also considered.

10. Integrative Graduate Education and Research Training (IGERT)—Seeks to enable the development of innovative, research-based graduate education and training activities that will produce a diverse group of new scientists and engineers who are well prepared for a broad spectrum of career opportunities. Projects supported must be based on a multidisciplinary research theme and organized around a diverse group of investigators from Ph.D.-granting institutions in the United States with appropriate research and teaching interests and expertise. For further information, see program solicitation NSF 00-78, or visit the IGERT web site, http://www.nsf.gov/home/crssprgm/igert/start.htm.

11. Major Research Instrumentation (MRI)—Supports projects that have one primary research focus and whose infrastructure requirement is too costly for other programs. All institutions are eligible, with a limit of two proposals from each institution per year. Matching at the 30-percent level is expected. For further information, see program solicitation NSF 99-168, or visit the MRI home page, http://www.nsf.gov/od/oia/programs/mri/start.htm.

12. Next Generation Software (NGS)— The overall thrusts of NGS are research and development for new software technologies integrated across a system's architectural layers; support for the design and the operation cycle of applications, computing, and communications systems; and delivering quality of service (QoS). For specific program information, see program announcement NSF 00-134.

NGS fosters multidisciplinary software research under two components:

- Technology for Performance Engineered Systems (TPES): Supports research for methods and tools leading to the development of performance frameworks for modeling, measurement, analysis, evaluation, and prediction of performance of complex computing and communications systems, and of the applications executing on such systems.

- Complex Application Design and Support Systems (CADSS): Supports research on novel software for the development and runtime support of complex applications executing on complex computing platforms. This includes programming models, new compiler and runtime technology, application composition environments, and debugging tools. CADSS-fostered technology breaks down traditional barriers in existing software components in the application development, support, and runtime layers, and will leverage TPES-developed technology for delivering QoS.

13. NSF-CONACyT Collaborative Research Opportunities—Supports, jointly between NSF and the Consejo Nacional de Ciencia y Tecnologia (CONACyT) (National Council of Science and Technology Research) of Mexico, efforts in international cooperative research and research infrastructure in computer science, information systems, computer engineering, and engineering research, including environment and manufacturing, civil, chemical, electrical, mechanical, and biomedical systems. Proposals from Mexican researchers and research institutions are selected and administered by CONACyT and are subject to the regulations of the Program for the Support of Science in Mexico. Proposals to NSF from researchers at institutions in the United States are subject to standard NSF review procedures and will be processed by the CISE Directorate and by NSF's Directorate

for Engineering. Proposals are accepted in all areas usually covered by the Directorate. For specific program information, see program announcement NSF 96-145.

14. NSF-CNPq Collaborative Research Opportunities—Supports, jointly between NSF and CNPq-Conselho Nacional de Desenvolvimento Cientifico e Tecnologico da Pesquisas (National Council of Scientific and Technological Research) of Brazil, new efforts in international cooperative research in any CISE-related area where the efforts are likely to produce positive, complementary, and synergistic effects.

The initiative seeks to advance scientific and engineering knowledge in areas of interest to the CISE Directorate through joint research efforts by investigators who have complementary talents and interests. The initiative capitalizes on the international character of modern scientific research and the ability to conduct collaborative research from a distance through the support of computer network infrastructures.

Proposals from Brazilian researchers and research institutions are selected and administered by CNPq's ProTem Office (Programa Tematico Multiinstitucional em Ciencia da Computacao) and are subject to the standards for submission and review of that organization. Proposals to NSF from researchers at institutions in the United States will be subject to standard NSF review procedures outlined in the NSF *Grant Proposal Guide* (see http://www.nsf.gov/cgi-bin/getpub?gpg for latest version) and will be processed by the CISE Directorate. For specific program information, see program announcement NSF 98-139; or contact Larry Brandt, program director, by telephone, 703-292-8980, or by e-mail, lbrandt@nsf.gov; or visit the NSF-CNPq web site, http://www.cnpq.br.

15. Research Experiences for Undergraduates (REU)—Provides opportunities for undergraduate students to experience hands-on participation in research and related scholarly activities. Active research experience is one of the most effective techniques for attracting talented undergraduates to and retaining them in careers in mathematics, science, and engineering. The REU Program, a Foundation-wide effort, is designed to help meet this need. REU has two components: one supports sites for several students; the other supplements awards to existing research grants for one or two students. For more information on REU, see program announcement NSF 01-121; or refer to the "REU Points of Contact at NSF" list on the REU web site, http://www.nsf.gov/home/crssprgm/reu/start.htm.

16. Special Projects—Supports activities to expand opportunities for women, minorities, and persons with disabilities in computer and information science and engineering and for special workshops, symposia, and analytical studies of interest to the CISE Directorate. Potential proposers are strongly encouraged to contact a program director to discuss their project ideas before submitting a proposal.